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THE EFFECT OF STAND IMPROVEMENT MEASURES IN THE WESTERN WHITE PINE TYPE ON THE GROWTH AND REGENERATION OF UPLAND RIBES

by

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INTRODUCTION

For some time those engaged in blister rust control, silvicultural investigations and timber management have recognized the need for coordinating their activities to assist in the natural suppression of ribes in the western white pine type. Although these coordinated activities are not expected to displace ribes eradication for the control of blister rust they should simplify the task of permanent ribes suppression. Since this matter is of vital interest to both the white pine ecologist and the silviculturist, the Bureau of Entomology and Plant Quarantine and the Northern Rocky Mountain Forest and Range Experiment Station in 1938 joined in a cooperative undertaking to study the effect of stand improvement work on the ribes population. The basis of cooperation and the responsibilities of the two agencies are described in a memorandum of understanding dated August 15, 1938.

Prior to 1938, ecology studies were chiefly concerned with general phases of the germination and growth of ribes and with the effects of commercial logging on upland ribes. When the Experiment Station program was expanded in 1934 the Blister Rust Control Office, in cooperation with the Experiment Station established a series of ribes ecology studies on a few of the silvicultural plots in the Deception Creek area. Through lack of funds and personnel the ribes ecology work at the Deception Creek station was discontinued from 1935 to 1937.

It is generally recognized that improvement measures are often required on many areas to secure and maintain second growth stands of high quality white pine on the better sites. The need for silvicultural work becomes increasingly apparent as the acreage of cut-over land supporting a predominance of the undesirable species is increased by logging. The heavy investment necessary to protect white pine from fire and diseases makes it economically essential that the better white pine areas be maintained at full productivity. Such areas can be made to produce higher values by the timely application of stand improvement work.

The results of previous ecology studies indicate that stand improvement measures can materially aid in the problem of ribes suppression and the ultimate control of blister rust if two important ecological facts are taken into consideration. The first is that the forest floor, or organic mantle, usually contains large numbers of viable ribes seed that will germinate if this mantle is generally disturbed. The second is that radical canopy changes combined with severe ground disturbances are conducive to the rapid growth and development of the ribes following germination. Two objectives therefore appear desirable: (1) to control the germination of stored ribes seed, and (2) to inhibit the permanent establishment of the seedlings that germinate.

The studies herein reported were undertaken for the purpose of utilizing previously established ribes ecology data for interpreting the results of stand improvement in the western white pine type on the regeneration and growth

of upland ribes.

STATUS OF STUDY AREAS

The effect of stand improvement on the development and spread of blister rust may be measured by the degree to which the two major upland ribes species, Ribes viscosissimum and R. lacustre are stimulated or retarded. Although R. lacustre is also an important stream type ribes, stream type conditions are not importantly represented in stand improvement areas. For this reason the discussion of R. lacustre throughout this report refers to its upland occurrence and habits.

Unfortunately, on the majority of the areas examined, some time had elapsed between the date of silvic treatment and the first ribes observations. The exact number of ribes seedlings germinating and their mortality rate are therefore not available for this report. The data secured on surviving bushes however, are significant because they largely determine the practical effect of any stand treatment on the regeneration of ribes.

One variable has entered into these studies that may have affected the results of the ecologic check on ribes populations. The initial eradication work was practically complete on all the areas examined prior to the establishment of the silvicultural plots. Except for a reduction in veteran ribes bushes, this working probably did not seriously affect the regeneration of ribes after the actual treatment of the stand. A second working, however, had been undertaken on a few of the areas following silvic treatment. It is therefore possible that a few ribes seedlings were removed during the eradication work. Some disturbance that might have caused seedlings to germinate may have resulted from the trampling by the eradication crews. Since both treated and untreated plots were subjected to the same operation, errors should compensate for each series of experimental plots.

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LIFE HISTORY OF UPLAND RIBES

In the stand improvement areas studied, R. lacustre and R. viscosissimum were the only two species of ribes present. On most of the plots the former species occurred alone. The life history of each ribes has been studied in order to establish its relation to the stand improvement measures and to the development of the white pine forest.

It is generally recognized that the length of time R. lacustre and R. viscosissimum can exist in the upland types depends primarily on the density

and composition of the forest stand. Competition commences early in the life of ribes when stands are composed of the more tolerant tree species. This is also noticeable in stands where the more intolerant trees are thrifty and constitute a relatively heavy stocking. The degree of competition beneath these developing canopies determines when the ribes population starts to decline. The degree of shade necessary to force out ribes does not appear to be inhibitory to successful establishment of white pine reproduction. This natural reduction of ribes has in some stands resulted in the death of nearly all bushes by the time the stand is 25 years old.

Of the two ribes species, R. lacustre is by far the more shade tolerant and widely distributed. Early in life there is a tendency for the lower portion of its stems to layer and become buried beneath an accumulation of forest debris. Once this layering has started the plant may continue to live by progressive asexual reproduction. As new root centers are established and aerial portions develop, the buried old stem dies off and the newly established plant is rejuvenated. This process enables R. lacustre to persist for many years under extremely adverse conditions until it ultimately becomes weakened and is lost in the succession. In contrast, R. viscosissimum, not a layering species, attempts to extend its life span by developing asexually from a distinct centralized root crown. New shoots of both species are strongly heliotropic and always grow toward the maximum light. In the course of stand development both species take on a characteristic forest form of slender, weak and spindling stems. As the canopy gradually closes the leaves become etiolated, thin in texture, and fewer in number per unit of shoot length.

Ribes viscosissimum is the first species to be eliminated from the stand, followed by R. lacustre. By the time of death both have left large quantities of viable seed stored in the organic mantle. These seed lie dormant until alteration of the forest floor is sufficient to encourage germination. The length of time that such stored seed will retain their viability has not been accurately determined, but evidence points to a period extending from the final ribes seed crop to the completion of the cutting cycle for the timber stand. Any procedure which disturbs the forest carpet without removing or destroying the seed provides a generally favorable condition for their germination. Studies have shown that the greater part of the viable ribes seed is stored in the lower limits of the organic mantle. The degree to which the upper layers of the forest mantle are disturbed or removed to expose the mineral soil largely determines the amount of seed germination.

Under favorable conditions stored seed of R. lacustre quite commonly continue to germinate throughout the life of a developing forest stand, even when buried deep in the organic mantle. This is evident where germination that is otherwise rare will be relatively abundant in years or growing seasons of abnormal moisture. Trampling may also terminate the period of seed inactivity. This type of disturbance is seldom apparent in a heavy forest carpet. Seedlings that germinate under unfavorable conditions usually exist in the uplands for only one to three years. The exceptions are those that start in the presence of abnormal summer rains or in direct contact with moist mineral soil. Their development, however, is usually abnormally slow unless sufficient light is available. R. viscosissimum seedlings do not germinate in significant numbers under these conditions.

A disturbance of the forest floor by fire usually results in germination of stored ribes seed, the number germinating being greatest for a light burn and smallest for an intense burn. The peak of germination following a burn occurs either the year of the burn or the year following, the exact time depending upon the time of year the disturbance occurs, the exposure, and the species of ribes. In general, the peak of germination for R. viscosissimum is reached one year in advance of the peak for R. lacustre. Disturbances brought about by purely mechanical means such as log skidding and road building are usually followed by the peak of germination during the second year for R. viscosissimum and the third year for R. lacustre. Following any type of disturbance, seed germination is practically complete for R. viscosissimum the third year and for R. lacustre the fourth year. Those seedlings germinating later either experience a high rate of mortality or are unable to develop normally due to severe competition. After disturbances other than fire the number of ribes appearing will usually be proportional to the degree of disturbance to which the forest floor is subjected.

The first fruiting of R. viscosissimum has been observed on three year old plants while the youngest recorded fruit bearing R. lacustre was four years of age. In neither case was the quantity of fruits large. The dangerous stage in seed production is reached when the plants are five or six years old. Seed storage then begins anew and increases thereafter unless interfered with by natural means or by the timely removal and destruction of the parent bushes.

When ribes seed germinate in the closing forest stand the plants are subjected to such severe competition for light and moisture that they rarely become permanently established. Those seed that fail to germinate eventually find their way to the bottom of the organic mantle either through a gradual sifting process or through the slow disintegration of the duff and humus from below. If the degree of stocking, composition and specific constitutions of the developing forest cover are unfavorable for ribes plant development there comes a time when an area which once supported large ribes populations becomes free of R. viscosissimum and practically free of R. lacustre. From this time on the developing forest holds in a state of dormancy the multitude of ribes seed which lie buried within its carpet unless fire, stand improvement measures, construction work or some other major disturbance restores a portion or all the environmental conditions which once were so favorable for the growth and development of ribes. When such dormancy is broken the number of seed which germinate will depend upon the quantity of viable seed, the amount of disturbance which the forest floor undergoes and the extent to which the forest canopy is removed.

METHODS

The field procedure employed in obtaining the ribes ecology data on the stand improvement plots was designed to take advantage of the established plot boundaries and to some extent followed the silvicultural checking methods of the Experiment Station. A string boundary was laid around each permanent sample plot and the interior gridironed by additional string lines. The width of lane between lines was governed by the type and density of the stand and the number of men available to complete a 100 percent check of the area. Data were recorded separately for each ribes species to show year of germination, growth per year, leaves per bush and the amount of infection for each seedling or veteran ribes

bush. The apparent germination cause was recorded as (1) mechanical disturbance, (2) light burn, (3) medium burn, (4) heavy burn, or (5) unknown, duff undisturbed. Since these plots were small, average light and moisture conditions were recorded for the entire silvic plot area. The amount of vegetative cover, exclusive of ribes was determined by milacre sampling across the strip and the plants found were listed by species in the order of their abundance and by the percentage of area occupied.

The sample areas studied, which represented extensively treated stand units were checked by the conventional strip method. The strips consisted of contiguous milacre samples taken along compass lines run progressively across the area at chain intervals. For each milacre ecology data were recorded for each ribes seedling. An ocular estimate was made of the absolute area occupied by the vegetative cover. For many of the areas examined the intensity of light beneath the canopy expressed in terms of percent full sunlight had been previously determined by the Experiment Station. Areas on which no calculations had been made were mentally compared with stands of known light intensity and the light factor was estimated along the strip at chain intervals. Soil moisture was recorded at chain intervals as being light, medium or heavy and upon the completion of the check an average classification was recorded. All ribes seedlings were removed from within the permanent sample plots and along the check strips to facilitate the recording of data and the protection of the experimental plots.

The veteran ribes bushes or those bushes originating prior to the establishment of the silvicultural plots were removed after recording of the required data. An examination was also made for ribes seedlings and the data recorded for each. An internode count was made to determine the year of germination of all ribes. In case of doubt or where it was impossible to make such a count for lack of yearly growth distinction, a ring growth count was made through the root crown with the aid of a 20X hand lens. Where it has been necessary to show silvicultural information to explain the type and nature of treatment the data secured by the Experiment Station have been used.

STAND IMPROVEMENT IN IMMATURE STANDS

CLEANING

Definition: Cuttings made in young stands averaging less than two inches in diameter breast high for the purpose of removing undesirable trees or shrubs that are injuring or are likely to injure promising trees. Synonym: "weeding".

Location, Description and Treatment of Stands

Deception Creek Experiment Station, Coeur d'Alene National Forest.

Permanent sample plots Nos. 42, 43, 44, 45 - A reproduction stand composed of western white pine, western hemlock and lowland white fir with hemlock and white fir largely dominating this 14 year age class. A medium to heavy overwood stand of mature hemlock and white fir formerly provided rather dense shade over the area. This overwood was removed by felling the mature and girdling the pole trees at the time of the cleaning. Cleaning removed approximately 72 percent

of an original per acre stocking of 18,000 tree seedlings over one foot in height. Slash was disposed of by piling and controlled burning during the fall of 1935. Ribes eradication was done on this area prior to the establishment of the silvicultural plots. Approximately 100 R. lacustre bushes per acre were removed and no R. viscosissimum. Moist conditions on this north exposure strongly favored the establishment of R. lacustre seedlings. The treated and untreated stands are shown in photographs Nos. W-2468 and W-2470.

Permanent sample plots Nos. 32 and 33 - A reproduction stand of white pine, white fir, and hemlock, which was largely dominated by white pine. Cleaning removed approximately 77 percent of an original per acre stocking of 4,800 tree seedlings over 0.6 inches d.b.h. Except for experimental purposes cleaning is not usually necessary in a stand dominated by white pine. On these plots there was no overhead shade and there had been no slash disposal work done. The ribes on this area were eradicated prior to the establishment of the plots and approximately 80 R. lacustre bushes per acre had been removed. There were no R. viscosissimum on the area.

Permanent sample plots Nos. 49, 50, 51, 52, 53, 54, 55, 56 and 57 - A reproduction stand composed of white pine, white fir, hemlock, and larch, with a large percentage of dominant white fir and hemlock. An overstory of white pine seed trees provided a light to medium overhead shade which was removed at the time of the cleaning. Treatment removed approximately 82 percent of an original per acre stocking of 7,800 tree seedlings over one foot in height. Slash was scattered and left on the area. Eradication measures were applied prior to the establishment of the plots. Approximately 100 R. lacustre bushes per acre were removed and an occasional R. viscosissimum. Conditions on part of the area are quite favorable for the establishment of ribes. The treated stand is shown in photographs Nos. W-2471 and W-2472.

Extensive sample areas Nos. 36-A and 36-B - Refer to permanent sample plots Nos. 42, 43, 44 and 45.

Extensive sample area No. 2 - Refer to permanent sample plots Nos. 49 to 57.

Upper West Branch of Priest River, Kaniksu National Forest.

Permanent sample plots Nos. 163 and 164 - A reproduction stand composed of white pine, hemlock, white fir, larch, and cedar, which was dominated by larch and white pine. A light overhead shade from white pine seed trees was removed at the time of the cleaning. Treatment removed about 54 percent of an original per acre stocking of 2,600 tree seedlings over one foot in height. Slash was disposed of by piling and burning during the fall of 1935. Eradication measures were applied to this area prior to the establishment of the experimental plots. Approximately 80 ribes per acre, about evenly divided between the two species, were removed.

Permanent sample plots Nos. 165, 166 and 167 - A reproduction stand of white pine, larch, white fir, hemlock, and cedar, strongly dominated by western larch. Cleaning removed about 64 percent of an original per acre stocking of 7,800 tree seedlings over one foot in height. No overhead shade was present on

W 2468. Deception Creek Experiment Station, Permanent Sample Plot No. 44. An untreated stand of white pine, hemlock and white fir, dominated by hemlock and white fir with a medium to heavy overwood stand of hemlock and white fir. Ribes definitely on the decline.

W 2470. Deception Creek Experiment Station, Area No. 36-A. Same stand as in W 2468 but reproduction "weeded" to favor white pine. Undesirable residual stand felled or girdled, slashed piled and burned. Conditions favoring the germination and survival of ribes seedlings.

W 2471. Deception Creek Experiment Station, Permanent Sample Plot No. 55. A treated reproduction stand of white pine, white fir, hemlock and larch that had a large percentage of dominant white fir and hemlock. White pine seed trees removed at time of cleaning, slash scattered. Ribes slowly on the decline due to unfavorable site.

W 2472. Deception Creek Experiment Station, Permanent Sample Plot No. 50. In same stand shown in W 2471. Note condition of scattered slash and scarcity of vegetative cover three years after treatment. A few sites often occur favoring the establishment of ribes seedlings.

W 2466. Kaniksu National Forest, Permanent Sample Plot No. 166. An untreated reproduction stand of white pine, larch, white fir, hemlock and cedar, dominated by western larch. Note the brush and the suppressed white pine in foreground. Ribes on the decline.

W 2467. Kaniksu National Forest, Permanent Sample Plot No. 165. Same stand as in W 2466, but reproduction "weeded" to favor white pine, slash piled and burned. Dry, well drained site unfavorable for the survival of ribes seedlings.

the area. Slash was piled and burned during the fall of 1935. This area was worked for ribes during 1934 and showed approximately 50 bushes per acre evenly divided between the two species. The treated and untreated stands are shown in photographs Nos. W-2466 and W-2467..

DISCUSSION

Results showing the effect of cleaning operations on the growth of veteran ribes bushes are presented in table 1. Bushes designated as veterans are ribes which originated before the establishment of the experimental plots. In the majority of cases these bushes were found to have appeared following the logging of these areas some 10 to 25 years ago. Practically every bush examined in the untreated dense reproduction stands had reached full maturity, or was overmature and on the decline. This fact should be kept in mind when examining the data on growth of ribes on treated areas.

Cleaning, which removes a large percentage of the trees, tends normally to open up the canopy to the extent of the cutting necessary to weed the stand satisfactorily. It would seem to follow then that any subordinate plant within the stand would correspondingly benefit from the smaller amount of shade. Shade as used in this case might be indicative of either diminished light or root competition. Examining the results in table 1 of the growth studies of ribes it is observed that live stem increased progressively following the cleaning operation. On the other hand, ribes growth in the untreated stands has remained more or less constant except for occasional fluctuations due to seasonal variations in the amount of moisture. The comparative growth rates of ribes during the last four years is considered highly significant in that established bushes when released have responded by the development of an abnormal amount of live stem and a larger number of leaves per bush. The increase in live stem comes from the regeneration of new shoots originating from the lower portion of old stems and occasionally from the root crown. It was of interest to note that the old stem continued to make about the same amount of normal yearly growth.

One important fact constantly observed in examining veteran ribes bushes is that more infection has developed on ribes in treated than in untreated stands. Pathologists have generally found that rust develops to a larger extent and with greater rapidity on the more succulent leaves produced by new shoots and those toward the terminal growth of the old stems. The development of new shoots alone would, therefore, result in bushes in treated areas becoming far more hazardous as hosts and spreaders of the rust than they were prior to the improvement work. Ribes should be removed shortly after the completion of the cleaning operation. Eradication work could be effectively done at this time because stand cleaning makes the ribes easier to find. The results of these studies strongly indicate that unless veteran ribes are removed before or shortly after the cleaning operation the areas will become potentially a greater rust hazard than those bearing the same number of suppressed ribes in closed stands.

Since it is not probable that the disturbance of the forest floor caused by the logging operation 10 to 25 years ago was extensive enough to cause a general germination of ribes seed at that time, an abundant quantity of stored viable seed should still be present on these areas. Between the time of germination following the logging disturbance and the time of eradication, ribes on

TABLE NO. 1

EFFECT OF CLEANING IMMATURE STANDS ON THE GROWTH OF VETERAN RIBES LACUSTRE BUSHES

Silvicultural Data						Ribes Ecology Data															
Plot No. and Location	Plot Treatment	Year Estab-lished	Age of Stand When Treated	Stand Density (Trees Per Acre) Before Treatment	Stand Density (Trees Per Acre) After Treatment	Acreage Checked	No. Ribes Per Acre	Total F.L.S. Per Acre Before Treatment	Annual Ribes Growth After Treatment (Feet of Live Stem) Per	1935	1936	1937	1938	Total F.L.S. Per Acre All Years	F.L.S. Per Bush	No. Leaves Per Bush	No. Infected Bushes Per Acre	No. Infected Leaves Per Acre	Expo-sure	Soil Moisture Content	Amount Associated Vegetative Cover (Percent)	Light Intensity (Percent Full Sunlight)
33									Acre	31.9	34.4	43.1	48.4									
D.C.E.S.[a]	Treated	1934	20	4,800[c]	1,100[c]	.25	40	128.9	Bush	.80	.86	1.08	1.21	286.7	7.20	98	20	96	E	Low	52	65
32									Acre	27.4	25.4	25.4	20.8									
D.C.E.S.	Untreated	1934	20	4,800[c]	4,800[c]	.25	28	180.2	Bush	.98	.91	.91	.74	279.2	10.0	48	4	4	E	Moderate	36	40
42,43									Acre	13.8	15.1	16.0	18.5									
D.C.E.S.	Treated	1935	14	18,000	5,000	.2	15	46.6	Bush	.92	1.00	1.07	1.23	110.0	7.33	138	5	10	N	Moderate	83	85
44,45									Acre	13.6	15.0	14.7	14.4									
D.C.E.S.	Untreated	1935	14	18,000	18,000	.2	70	70.6	Bush	.19	.22	.21	.21	128.3	1.83	13			N	Moderate	40	15
36-A									Acre	9.9	13.2	12.9	13.6									
D.C.E.S.	Treated	1935	14	18,000	5,000	2.2	13	54.3	Bush	.79	1.1	1.0	1.1	103.9	7.99	111	5	25	N	Moderate	62	85
36-B									Acre	2.3	2.6	2.2	3.1									
D.C.E.S.	Untreated	1935	14	18,000	18,000	.9	21	10.0	Bush	.11	.12	.10	.26	20.2	.96	7	2	2	N	Moderate	24	15
49,50,52,54,55,56									Acre	16.4	26.4	29.3	31.2									
D.C.E.S.	Treated	1935	16	7,800	1,400	.6	72	48.8	Bush	.23	.37	.41	.43	152.1	2.11	28	4	4	NW	Low	38	65
51,53,57									Acre	15.4	13.1	16.5	18.2									
D.C.E.S.	Untreated	1935	16	7,800	7,800	.3	43	139.1	Bush	.36	.31	.38	.42	202.3	4.70	55			NW	Low	34	55
2									Acre	14.8	23.1	36.3	34.8									
D.C.E.S.	Treated	1935	16	7,800	1,400	1.1	55	95.3	Bush	.27	.42	.66	.63	204.3	3.71	64	3	14	N	Low	36	70
164									Acre	5.6	6.9	7.0	11.5									
Kaniksu N.F.[b]	Treated	1935	10	2,600	1,200	.9	21	18.2	Bush	.27	.33	.33	.55	49.2	2.34	32			N	Low	79	60
163									Acre	8.5	13.7	11.0	13.1									
Kaniksu N.F.	Untreated	1935	10	2,600	2,600	.9	19	17.5	Bush	.45	.72	.58	.69	63.8	3.36	45			N	Low	65	40
165,167									Acre	.5	.7	.9	.6									
Kaniksu N.F.	Treated	1935	8	7,800	2,800	.8	1	.3	Bush	.40	.56	.72	.48	3.0	2.40	23			W	Low	58	90
166									Acre													
Kaniksu N.F.	Untreated	1935	8	7,800	7,800	.4			Bush										W	Low	33	55

[a] D.C.E.S.- Deception Creek Experimental Station, Coeur d'Alene National Forest.
[b] Kaniksu N.F.- Upper West Branch of Priest River, Kaniksu National Forest.
[c] Treatment applied to tree seedlings over 0.6 inches d.b.h., treatment of remaining plots includes all tree seedlings over one foot in height.

TABLE NO. 2

EFFECT OF CLEANING IMMATURE STANDS ON THE GROWTH AND REGENERATION OF RIBES LACUSTRE SEEDLINGS

Plot No. and Location	Treated or Untreated	Year Plot Estab-lished	Acreage Checked	Number Seedlings and Amount Live Stem Per Acre Each Year After Treatment										Accumulative Number Seedlings and Amount Live Stem Per Acre Each Year After Treatment										F.L.S. Per Seedling	No. Leaves Per Seedling	No. Infected Seedlings Per Acre	No. Infected Leaves Per Acre	Exposure	Soil Moisture Content	Amount Associated Vegetative Cover (Per Cent)	Light Intensity (Per Cent Full Sunlight)
				1934		1935		1936		1937		1938		1934		1935		1936		1937		1938									
				No.	F.L.S.	No.	F.L.S.	No.	F.L.S.	No.	F.L.S.	No.	F.L.S.	No.	F.L.S.	No.	F.L.S.	No.	F.L.S.	No.	F.L.S.	No.	F.L.S.								
33 D.C.E.S.[a]	Treated	1934	.25							12	1.2									12	1.2	12	3.8	.32	6			E	Low	52	65
32 D.C.E.S.	Untreated	1934	.25	8	3.1	16	1.7	12	1.0	32	2.7	4	.3	8	3.1	24	8.5	36	13.0	68	21.3	72	28.2	.39	6	8	24	E	Moderate	36	40
42,43 D.C.E.S.	Treated	1935	.2			10	2.0	50	9.0	80	7.0	10	.5			10	2.0	60	17.5	140	46.0	150	76.7	.51	13			N	Moderate	83	85
44,45 D.C.E.S.	Untreated	1935	.2					5	.4									5	.4	5	1.0	5	1.3	.26	5			N	Moderate	40	15
36-A D.C.E.S.	Treated	1935	2.2			8	5.1	30	17.7	37	19.5	3	1.3			8	5.1	38	32.3	75	87.3	78	141.6	1.81	19	6	59	N	Moderate	62	85
36-B D.C.E.S.	Untreated	1935	.9					3	.1	6	.6	2	.1					3	.1	9	.8	11	1.9	.17	7			N	Moderate	24	15
49,50,52,54,55,56 D.C.E.S.	Treated	1935	.6			2	1.1	12	5.1	6	1.3					2	1.1	14	7.4	20	14.9	20	19.6	.98	17	2	2	NW	Low	38	65
51,53,57 D.C.E.S.	Untreated	1935	.3			3	1.3	15	7.4	8	1.6					3	1.4	18	10.3	26	20.7	26	27.5	1.10	17	2	2	NW	Low	34	55
2 D.C.E.S.	Treated	1935	1.1					3	.3	12	1.6	2	.1					3	.3	15	3.1	17	7.8	.46	12	1	1	N	Low	36	70
164 Kan. N.F.[b]	Treated	1935	.9					1	.1									1	.1	1	.2	1	.3	.31	9			N	Low	79	60
163 Kan. N.F.	Untreated	1935	.9																									N	Low	65	40
165,167 Kan. N.F.	Treated	1935	.8																									W	Low	58	90
166 Kan. N.F.	Untreated	1935	.4																									W	Low	33	55

[a]D.C.E.S. Deception Creek Experimental Station, Coeur d'Alene National Forest
[b]Kan. N.F. Upper West Branch of Priest River, Kaniksu National Forest
Refer to Table No. 1 for Silvicultural Data

the area had a number of years in which to produce many crops of new seed. These areas, therefore, were considered as having a potential reserve of seed ready to germinate whenever conditions of the forest floor became altered to release them from dormancy. The extent to which a cleaning operation would alter natural conditions depends largely upon the amount of mechanical disturbance normally accompanying the operation and the subsequent treatment of slash.

The results of ribes seedling studies on the experimental cleaning plots are presented in table 2. It should be borne in mind that the number of ribes which normally appear on an area will be largely in proportion to the degree of disturbance which the forest floor undergoes during the operation. The greater number of seedlings should thus regenerate on the areas subjected to the heaviest cuttings. This of course would be true if during the cleaning work a duff and litter disturbance actually results from trampling, tree cutting, etc. Cleaning without the major disturbances of logging would affect the regeneration of ribes only to the extent of the mechanical disturbance attendant to the cutting. Also, changes in environmental conditions should be more noticeable when release is given to heavily stocked stands because conditions which accompany a full forest cover do not normally favor the growth of subordinate vegetation.

A relatively heavy stocking is still retained on the majority of areas after the completion of the cleaning operation. Considering cover and other factors which affect the establishment of ribes, conditions were highly unfavorable for the regeneration and growth of seedlings on most of the cleaning areas examined. Since the shade factor will gradually increase as the stand recloses a period of a few years can be expected in which site conditions may favor to some extent the temporary establishment of occasional ribes seedlings unless interfered with by their timely removal.

An examination of the seedling data reveals that areas with the greater original stocking had at the end of three years the larger number of established ribes. The disturbance responsible for the germination of these seedlings was attributed largely to causes other than those which might result from the cleaning treatment or actual tree cutting. Fewer ribes were found surviving on treated areas where there had been no slash burning than on untreated checks, but this difference is not considered highly significant at this time. It might indicate that site conditions were somewhat less favorable for the survival of ribes following the release of the stand but not for the germination of the ribes seed since the treated plots were subjected to some disturbance. Moisture conditions that normally favor the germination of ribes seed may later be of insufficient quantity to sustain their development. This fact was considered highly significant in determining the number of ribes to become established, especially on the cleaning areas in the Kaniksu National Forest. It appeared also to be the limiting factor responsible for fewer ribes in the treated plots within Area No. 2. Since the results of these ribes studies have been taken from sites largely favoring the development of ribes, indications are that a reasonable degree of cleaning in which the slash is scattered does not produce conditions permitting the establishment of serious ribes hazards.

Brush disposal by burning, while not an actual part of cleaning is a protective measure often used in reducing heavy hazards in the treatment of very dense stands. Areas on which the original stocking is not extremely heavy can

often be cleaned without producing hazardous conditions from the slash. In such cases the slash is lopped and scattered. Brush disposal by burning following logging operations has been observed to be the most important agency in the bringing in of large ribes populations. Many times more seedlings can be expected to appear on burned areas than on areas subjected only to mechanical disturbances. Severe burns are known to destroy a large portion of the viable stored ribes seed.

It was found on the treated area No. 36-A, which also included the permanent sample plots Nos. 42 and 43, that better than 96 percent of the seedlings germinating were either within or closely adjacent to burned brush piles. Practically all the seedlings within the burned area appeared on the outer rim or boundary of the burned pile, indicating that heat failed to destroy the seed. Seedlings found adjacent to and around the burned piles had germinated as a result of mechanical disturbance accompanying the burning operation. The preparation of brush piles which required considerable trampling over the same ground near the edge of the piles had caused disturbances severe enough to materially affect the germination of ribes seed. This disturbance would not normally accompany progressive cleaning in which the slash is left usually in place or merely scattered if too dense. Results indicated that better than 96 percent of the seedlings found on this area would not have germinated if the brush had not been assembled into piles and burned. The burning of slash has appeared to be the only factor of practical importance favoring the germination of ribes seed in a cleaning operation.

Growth of ribes and other vegetation were favored on areas in which the slash was burned. Ribes growth was less per bush on treated areas where the slash had been scattered and left unburned than in untreated dense reproduction stands. All of the present studies show that the cleaning measures in which the slash is left unburned create conditions largely unfavorable for the establishment of ribes seedlings.

THINNING

Definition: A cutting made in a dense immature stand averaging more than two inches in diameter breast high for the purpose of increasing the growth rate of the trees that are left and of improving the composition and quality of the stand.

Location, Description and Treatment of Stand

Deception Creek Experiment Station, Coeur d'Alene National Forest.

Permanent sample plots Nos. 26, 27, 28, 29 and 30 - A very dense stand of pole was occupying a southeast slope. White pine largely dominated the stand with white fir, Douglas fir and a little lodgepole pine making up the balance of the stand. The different weights of thinning removed all suppressed and intermediate trees and some dominant and codominant trees of poor form and undesirable species. Most of the slash was dragged to the road and progressively burned in small piles; some however was piled and progressively burned in the stand, and a small amount was lopped and left unburned. Eradication measures were applied prior to the establishment of the plots. Approximately 20 R. lacustre were

removed per acre; there were no R. viscosissimum. Heavy thinning on south exposure is shown in photograph No. W-2473.

Permanent sample plot No. 37, Latin Square - Low thinning - A very dense stand on northeast slope was composed of about half white pine. Balance of stand white fir with smaller amounts of hemlock and Douglas fir. Thinning from below removed practically all suppressed and intermediate trees and some dominant and codominant trees of poor form and condition. From six to ten large "wolf" trees per acre were girdled and the smaller trees felled. The slash was thoroughly lopped and placed as close to the ground as possible and no burning was done. Crown thinning - The same stand description and treatment of slash as described under low thinning. The best trees for future growth, favoring white pine wherever possible, were selected and released from competition, particularly in the crowns. Noncompeting trees including practically all suppressed trees and most of the intermediate trees were left uncut. Moist conditions on this northeast exposure favored the establishment of R. lacustre.

Permanent sample plots Nos. 46, 47, 48 and 59 - A dense stand on a lower north slope consisting mainly of hemlock with the balance composed of white pine and white fir with a little Douglas fir and alpine fir. A heavy thinning from above favoring white pine released trees of this species wherever they appeared capable of becoming final crop trees. Only trees materially competing with selected trees were cut. Most of the suppressed and a large share of the intermediate trees were left uncut. Fire lanes were constructed 20 to 30 feet wide at intervals of five chains gridironing the area and cleared of all slash by piling and burning. On the rest of the area slash was lopped and scattered as close to the ground as possible. Unusually heavy snow and wind throw had occurred on some of the area which resulted in abnormal disturbances. Ribes were eradicated from this area prior to the establishment of the experimental plots. Approximately 80 R. lacustre bushes were removed per acre. Moisture highly favored the establishment of ribes but shading was still too severe for normal growth. The treated stand is shown in photograph No. W-2476.

Fourth of July Canyon, Coeur d'Alene National Forest.

Permanent sample plots Nos. 38, 39, 40 and 41 - This was a vigorous and very dense stand of white pine and larch with lesser amounts of white fir and Douglas fir on an east exposure. An understory of cedar and hemlock was present. The stand was thinned from below to favor white pine with larch as second choice. A cedar understory was left and all other trees were cut in the thinning operation. The slash was progressively burned in small piles within the stand during the late fall. No eradication work was performed on this area before the completion of the ecology check. The area was distinctly a R. viscosissimum site as evidenced by the results of the check.

Cats Spur, Clarkia, Idaho, St. Joe National Forest.

Sample areas Nos. A, B and C - A very dense and vigorous stand was dominated by white pine with lesser amounts of white fir, Douglas fir, lodgepole pine, larch, cedar, and hemlock on south and northwest exposures. The thinning from below to favor white pine removed all suppressed and intermediate trees and the "wolf" trees were felled. The slash was progressively burned in small piles

W 2473. Deception Creek Experiment Station, Permanent Sample Plot No. 26. A heavy thinning from below in a very dense stand of white pine, white fir, Douglas fir and lodgepole pine. Conditions favor the establishment of many ribes seedlings on moist exposures.

W 2476. Deception Creek Experiment Station, Permanent Sample Plot No. 48. A heavy thinning from above in a very dense stand of white pine, hemlock, white fir, Douglas fir and alpine fir. Photograph does not illustrate typical treatment because of unusually heavy snow and wind throw. Conditions moderately favorable for germination of ribes seed, mortality of seedlings extremely high under these conditions.

within the stand during late fall and winter. Eradication measures were applied prior to the thinning of the stand, removing approximately 300 ribes per acre about two thirds of which were R. lacustre and the remainder R. viscosissimum.

Priest River Experiment Station, Kaniksu National Forest.

Permanent sample plots Nos. 157, 158, 159, 160 and 161 - A very thrifty and well stocked stand was composed of white pine, larch, white fir, Douglas fir, with an understory of cedar. Thinning from below removed all defective trees and trees in the lower crown classes, white pine, larch and cedar were favored by the treatment. The slash was piled and burned in small piles within the stand during the late fall. Eradication measures were applied in 1934 at which time approximately 105 ribes per acre were removed; they were evenly divided between the two species R. lacustre and R. viscosissimum.

DISCUSSION

Thinning is essentially similar to cleaning in character but applied to dense stands usually between 20 and 50 years of age where the desirable species are badly in need of release. Two general systems of thinning, referred to as the low and the crown are applicable. The low thinning or thinning from below is essentially an anticipation of the natural thinning which goes on in every stand. To date this method has been more extensively employed than the crown thinning in the white pine type. Crown thinning or thinning from above anticipates the development of the stand a long time in advance and the trees which are chosen for the final stand are selected and favored early in life. The direct effect of either type of thinning on the ecology of ribes will largely depend upon the extent to which the stand is opened, the amount of ground disturbance accompanying the operation, and the subsequent treatment of the slash. Since there are different weights of thinning, ribes might be expected to appear in direct proportion to the extent to which natural conditions are changed. An indirect effect of the heavy thinning of dense stands is the increased susceptibility of the residual trees to wind throw and snow breakage. Such disturbances may later affect the germination and survival of ribes seedlings.

Ribes populations in dense pole stands have for a long period of years been subjected to such severe competition that many areas in need of thinning are found to be relatively free of ribes. If ribes are present in these areas they are usually R. lacustre which will be found in moist and fairly open sites. The bushes are usually large, partially decadent veterans bearing long stems with but few leaves on the terminal growth. Such bushes are not considered highly hazardous and once removed the areas should be protected for an indefinite period. No major ribes seedling problem has been known to develop on such areas unless natural conditions are materially altered. The status of control on these areas will therefore be dependent upon the extent to which thinning is applied to these dense stands.

The results showing the effect of the two types of thinning on the growth of veteran ribes bushes are presented in table 3. Ribes responded about equally well immediately after each type of thinning. Heavy low thinning apparently favors the progressive development of live stem although the basis of only four ribes bushes per acre is hardly sufficient for reasonable proof. Heavy crown

TABLE NO. 3

EFFECT OF THINNING IMMATURE STANDS ON THE GROWTH OF VETERAN RIBES LACUSTRE BUSHES

Plot No. and Location	Degree of Thinning	Year Plot Estab-lished	Age of Stand When Treated	Stand Density (Trees Per Acre) Before Treatment	Stand Density (Trees Per Acre) After Treatment	Acreage Checked	No. Ribes Per Acre	Total F.L.S. Per Acre Before Treatment	Annual Ribes Growth After Treatment Feet of Live Stem Per	1935	1936	1937	1938	Total F.L.S. Per Acre All Years	F.L.S. Per Bush	No. Leaves Per Bush	No. Infected Bushes Per Acre	No. Infected Leaves Per Acre	Expo-sure	Soil Moisture Content	Amount Associated Vegetative Cover (Percent)	Light Intensity (Percent Full Sunlight)
Low Thinnings or Thinning from Below																						
A St. Joe N.F.[a]	Light	1936	50	Unknown		1.0	8	11.3	Acre		2.0	2.9	3.6	19.8	2.48	27	6	117	NW	Moderate	34	55
									Bush		.25	.36	.45									
C St. Joe N.F.	Check	1936	50	Unknown		1.0	6	7.6	Acre		1.6	1.4	1.7	12.3	2.05	16	1	2	NW	Moderate	23	35
									Bush		.27	.23	.28									
37 D.C.E.S.[b]	Heavy	1935	45	5,800	420	.72	4	9.9	Acre	3.0	3.6	4.6	5.8	26.9	6.73	109	3	47	E	Moderate	22	70
									Bush	.75	.90	1.15	1.45									
37 D.C.E.S.	Light	1935	45	5,800	860	.72	22	113.7	Acre	21.9	24.3	24.3	22.1	206.3	9.38	69	8	29	E	Moderate	21	40
									Bush	1.00	1.10	1.10	1.00									
37 D.C.E.S.	Check	1935	45	5,800	5,800	1.44	31	54.8	Acre	5.2	6.3	6.4	6.1	78.8	2.54	13	4	16	E	Moderate	18	15
									Bush	.68	.83	.83	.79									
Crown Thinnings or Thinning from Above																						
37 D.C.E.S.	Heavy	1935	45	5,800	4,510	.72	26	134.8	Acre	25.0	21.9	21.6	20.0	223.3	8.59	59	14	101	E	Moderate	23	45
									Bush	.96	.84	.83	.77									
37 D.C.E.S.	Light	1935	45	5,800	4,730	.72	19	154.1	Acre	19.2	20.4	19.9	20.7	234.3	12.3	90	18	318	E	Moderate	29	25
									Bush	1.01	1.07	1.05	1.09									
37 D.C.E.S.	Check	1935	45	5,800	5,800	1.44	15	49.0	Acre	7.8	7.5	8.0	7.1	79.4	5.29	29	9	35	E	Moderate	21	40
									Bush	.52	.50	.53	.47									
46 D.C.E.S.	Light	1935	60	2,460	2,080	.4	8	14.3	Acre	1.9	2.5	3.5	3.5	23.8	2.98	11			N	Moderate	18	30
									Bush	.25	.31	.44	.44									
48 D.C.E.S.	Heavy	1935	60	2,460	1,720	.4	5	6.7	Acre	1.1	1.6	2.3	3.2	13.8	2.76	21			N	Moderate	26	65
									Bush	.28	.32	.46	.64									
47-59 D.C.E.S.	Check	1935	60	2,460	2,248	.8	14	25.1	Acre	3.2	3.5	3.3	3.0	34.9	2.49	11	5	8	N	Moderate	9	10
									Bush	.22	.25	.24	.21									

[a]St. Joe N.F.- Catspur, Clarkia, Idaho, St. Joe National Forest
[b]D.C.E.S.- Deception Creek Experimental Station, Coeur d'Alene National Forest

TABLE NO. 4

EFFECT OF THINNING IMMATURE STANDS ON THE GROWTH AND REGENERATION OF UPLAND RIBES SEEDLINGS

Plot No. and Location	Degree of Thinning	Year Plot Established	Age of Stand When Treated	Stand Density (Trees Per Acre) Before Treatment	Stand Density (Trees Per Acre) After Treatment	Acreage Checked	Ribes Species	Number Seedlings and Amount Live Stem Per Acre Each Year After Treatment: 1934 No.	1934 F.L.S.	1935 No.	1935 F.L.S.	1936 No.	1936 F.L.S.	1937 No.	1937 F.L.S.	1938 No.	1938 F.L.S.	Accumulative Number Ribes Seedlings and Amount Live Stem Per Acre Each Year After Treatment: 1934 No.	1934 F.L.S.	1935 No.	1935 F.L.S.	1936 No.	1936 F.L.S.	1937 No.	1937 F.L.S.	1938 No.	1938 F.L.S.	F.L.S. Per Seedling	No. Leaves Per Seedling	No. Infected Seedlings Per Acre	No. Infected Leaves Per Acre	Exposure	Soil Moisture Content	Amount Associated Vegetative Cover (Percent)	Light Intensity (Percent Full Sunlight)
Low Thinnings or Thinning from Below																																			
26 D.C.E.S.[a]	Heavy	1933	60-65	1,700	268	.25	Ribes lacustre			12	4.1			8	.9					12	4.1	12	10.7	20	15.3	20	19.8	.99	43	4	4	S	Low	45	60
27,28 D.C.E.S.	Light	1933	60-65	1,700	462	.50	Ribes lacustre					2	.6	6	1.3							2	.6	8	2.5	8	3.6	.45	12			S	Low	29	45
29 D.C.E.S.	Light	1933	60-65	1,700	436	.25	Ribes lacustre	4	1.1			32	7.0	252	28.1	12	.8	4	1.1	4	1.7	36	9.2	288	42.4	300	78.9	.26	8	8	12	E	Moderate	20	35
30 D.C.E.S.	Heavy	1933	60-65	1,700	236	.25	Ribes lacustre			20	6.5	44	13.3	384	54.0	28	1.8			20	6.5	64	25.4	448	97.3	476	165.2	.35	9	4	12	E	Moderate	22	50
Area No. 1 D.C.E.S.	Light	1933	60-65	1,550	415	.54	Ribes lacustre			19	8.1	81	19.4	167	13.1	7	.4			19	8.1	100	38.0	267	100.3	274	166.1	.61	14	13	70	S&E	Moderate	33	40
16,17 D.C.E.S.	Check	1933	60-65	1,700		.50	Ribes lacustre					2	.4	66	4.2	46	2.5					2	.4	68	6.1	114	14.1	.12	5	2	6	E	Low	3	15
37 D.C.E.S.	Heavy	1934	45	5,800	420	.72	Ribes lacustre	3	.9	1	.2	1	.2	10	1.7			3	.9	4	1.6	5	2.9	15	6.2	15	11.5	.77	14	5	26	SE	Moderate	22	70
37 D.C.E.S.	Light	1934	45	5,800	860	.72	Ribes lacustre																									SE	Moderate	21	40
37 D.C.E.S.	Check	1934	45	5,800		2.88	Ribes lacustre							1	.1	1	.1							1	.1	2	.2	.10	3			SE	Moderate	18	15
A St. Joe N.F.[b]	Light	1936	50	Unknown		1.0	Ribes lacustre							60	4.6	75	5.5							60	4.6	135	16.1	.12	4	37	90	NW	Moderate	34	55
B St. Joe N.F.	Light	1936	50	Unknown		1.0	Ribes lacustre																									S	Low	64	80
C St. Joe N.F.	Check	1936	50	Unknown		1.0	Ribes lacustre							1	.1									1	.1	1	.2	.22	7			NW	Moderate	23	35
38 Coeur d'Alene N.F.[c]	Light	1934	30-35	2,500	455	.25	Ribes viscosissimum			4	.17	160	7.8	20	1.3					4	.17	164	8.2	184	20.7	184	35.2	.19	4			E	Low	19	65
40 Coeur d'Alene N.F.	Heavy	1934	30-35	2,500	496	.25	Ribes viscosissimum			100	5.2	108	10.6	4	.2					100	5.2	208	28.4	212	52.2	212	74.3	.35	5			E	Low	32	85
39,41 Coeur d'Alene N.F.	Check	1934	30-35	2,500		.50	Ribes viscosissimum																									E	Moderate	7	30
157,158,159 P.R.E.S.[d]	Light	1933	75	1,100	530	.75	Ribes lacustre			1	.12	4	.7							1	.12	5	.87	5	1.64	5	2.46	.49	5			E	Moderate	12	35
160 P.R.E.S.	Heavy	1933	75	1,100	224	.25	Ribes lacustre	4	1.7	4	.2							4	1.7	8	3.2	8	4.9	8	6.0	8	6.73	.84	17			E	Moderate	15	60
161 P.R.E.S.	Check	1934	75	1,100		.25	Ribes lacustre							12	.97									12	.97	12	1.93	.16	6			E	Moderate	5	15
Crown Thinnings or Thinning from Above																																			
46 D.C.E.S.	Light	1935	60	2,460	2,080	.40	Ribes lacustre			3	1.4	5	2.8	3	.4	3	.2			3	1.4	8	5.4	11	9.3	14	11.6	.83	7			N	Moderate	18	30
48 D.C.E.S.	Heavy	1935	60	2,460	1,720	.40	Ribes lacustre			3	1.3	8	1.7	295	14.5	18	.6			3	1.3	11	4.9	306	22.8	324	52.9	.16	7	10	10	N	Low	26	65
47,59 D.C.E.S.	Check	1935	60	2,460	2,248	.80	Ribes lacustre			2	.4									2	.4	2	.5	2	.6	2	.7	.35	4			N	Moderate	9	10
Area No. 10 D.C.E.S.	Light	1935	60	2,460	1,900	2.2	Ribes lacustre			1	.5	102	6.7	243	15.5	26	1.3			1	.5	103	6.9	346	34.9	372	67.5	.18	7	10	72	N	Moderate	17	45
Area No. 10 D.C.E.S.	Fire Lanes	1935	60	2,460		.34	Ribes lacustre					26	3.9	1474	171.4	312	23.9					26	3.9	1500	183.3	1812	557.7	.31	11	94	526	N	Moderate	83	90
37 D.C.E.S.	Heavy	1934	45	5,800	4,510	.72	Ribes lacustre							32	2.2	3	.1							32	2.2	35	3.9	.11	6			E	Moderate	23	45
37 D.C.E.S.	Light	1934	45	5,800	4,730	.72	Ribes lacustre					1	.1									1	.1	1	.4	1	.6	.60	3			E	Moderate	29	25

[a] D.C.E.S.- Deception Creek Experimental Station, Coeur d'Alene National Forest
[b] St. Joe N.F.- Catspur, Clarkia, Idaho, St. Joe National Forest
[c] Coeur d'Alene N.F.- Fourth of July Canyon, Coeur d'Alene National Forest
[d] P.R.E.S.- Priest River Experimental Station, Kaniksu National Forest

thinning caused the immediate growth of ribes and thereafter live stem decreased progressively following the operation. The growth rate of ribes live stem increased after the stand release and then approached apparent equalization in both types of light thinning. Wind throw and snow breakage in crown thinned areas produced relatively similar conditions to low thinnings which favored the temporary development of ribes. Because of the removal of undergrowth low thinnings increased the visibility of ribes for eradication work. In practically all cases thinning increased the proportion of infected ribes and the intensification of the rust. These studies indicated that a full forest cover held just above the ribes greatly enhances the shading-out process. Results showed that thinning from above created a less favorable condition for ribes regeneration than thinning from below unless heavy wind throw and snow breakage had occurred following the operation.

Data showing the effect of the two types of thinning on the growth and regeneration of ribes seedlings are presented in table 4. As previously mentioned no significant germination of ribes seed has been known to occur on undisturbed areas in need of thinning. Ribes lacustre seedlings may germinate under these conditions, but they rarely become permanently established within the dense pole type. The extent to which thinning will encourage germination depends principally upon the ground disturbance accompanying the operation and the subsequent treatment of slash. The percentage survival of these seedlings will largely be determined by the weight of thinning responsible for the removal of shade.

Both types of thinning were found to cause germination of ribes seed by mechanical disturbances. The number of seedlings appearing was observed to be largely in proportion to the weight of thinning, heavier cutting causing a greater disturbance of the forest floor. A more general mechanical disturbance occurred on the low thinning areas. The dragging of slash off the plots or into piles on the thinned areas had accounted for more ribes seedlings than would otherwise have appeared. In a few cases where the duff mantle was thin, trampling had caused germination of ribes seed. The majority of these seedlings were very weak and were rapidly disappearing. Because of heavy shading only a small percentage of the seedlings originating on mechanically disturbed area can be expected to become permanently established in the lighter thinned stands. The results of these studies strongly indicate that the majority of ribes seedlings, especially R. lacustre, appearing in the stand after a heavy low thinning will become permanently established. Survival of the seedlings will of course depend largely on the exposure, being lowest on south slopes and increasing on west east and north exposures in the order named.

The piling and burning of slash were observed to account for many times more seedlings than the mechanical disturbance of the area. Burning was not only the most important agency that stimulated ribes germination but it materially aided their establishment by the consumption of the duff mantle. The effect of burning on the regeneration of ribes seedlings is very noticeable on area No. 10, crown thinning for nearly five times as many ribes appeared in the fire lanes as on adjacent thinned area subjected only to a ground disturbance. Since these fire lanes were cleared of all trees, conditions were much more favorable for the germination and survival of ribes seedlings than would normally be the case within a thinned stand. The thinned area on which subsequent wind throw and snow breakage are extensive may be considered to have received the maximum disturbance for treated stands of this type. The comparison of these two disturbances appears

highly significant in showing that ribes regeneration is more affected by the burning of slash than by the mechanical disturbance of the forest floor.

For R. lacustre the peak of germination on mechanically disturbed areas occurred as late as four years following the thinning operation. The peak of germination on burned areas within thinned stands has generally occurred the second year after burning for R. viscosissimum and the third year for R. lacustre. Since the complete record of germination by years following thinning is not available, the peak may have been reached sooner than is indicated and all evidence lost by a high mortality of seedlings.

In general, the growth of ribes has been stimulated by both types of thinning. The ecologic study showed that heavy low thinning permits the more rapid development of ribes and creates conditions largely in favor of R. lacustre. As this type of thinning became lighter, fewer seedlings were found surviving under the heavier canopy. The low thinning operation was observed to have caused a more general and extensive mechanical disturbance of the forest floor. The disturbance was generally minimized and occurred only in patches on the crown thinned areas. The development of live stem on ribes seedlings appeared to decrease as the degree of crown thinning became heavier. This point is not considered highly significant at this time until further observations have been completed. The percentage of infected ribes was found to be greater on thinned areas and to be roughly proportional to the degree of thinning. Although both types of thinning will cause some ribes seed to germinate, crown thinnings will come nearest to creating conditions unfavorable for the development of ribes. The degree of cutting in either type of thinning should not exceed a light release of the stand if these measures are to assist in the suppression of ribes.

STAND IMPROVEMENT IN MATURE STANDS

Definition: Stand improvement in mature stands is primarily concerned with the disposal of mature trees of undesirable species to permit the establishment of desirable reproduction.

Location, Description and Treatment of Stands

Deception Creek Experiment Station, Coeur d'Alene National Forest.

Shelterwood area No. 12 - A mature 140 year old stand was largely dominated by white pine on a north and northeast exposure. The remainder of the stand was composed of hemlock, white fir and Douglas fir. The white pine were logged in 1935 by clear-cutting and shelterwood cutting in alternate strips each approximately five chains in width. All defective and unmerchantable trees were felled, leaving a shelterwood of white pine seed trees. In 1936 the slash was broadcast burned on the clear-cut strips and piled and burned on the shelterwood strips. This area was practically ribes free at the time of logging except for an occasional R. lacustre bush inhabiting moist sites. General conditions of the area are shown in photographs Nos. W-2482 and W-2483.

Pre-logging area No. 6 - A mature 160-200 year old stand was dominated by white pine growing on a south slope. The defective and unmerchantable hemlock and white fir were felled and the slash piled and burned to create shelterwood

conditions favorable for the establishment of white pine reproduction in advance of logging the residual white pine. The eradication measures applied previously to this area resulted in the removal of approximately 15 ribes bushes per acre. The treated stand is shown in photograph No. W-2485.

Pre-logging area No. 8 - A mature 101-200 year old stand was dominated by white pine growing on a north slope. The defective and unmerchantable hemlock and white fir were disposed of as described for area No. 6. The trees were felled and the brush piled in 1935. The slash was disposed of by burning during the fall of 1936. Ribes were removed previous to the treatment of this area and they occurred in relatively the same numbers and on identical sites as described for area No. 12. The treated stand is shown in photograph No. W-2484.

Pre-logging area No. 9 - A mature 161-200 year old stand was dominated by white pine on north slope adjacent to area No. 8. In the fall of 1934 all hemlock, white fir and Douglas fir over 7.6 inches d.b.h. were girdled. These same trees were regirdled in August of 1935. At this time trees under 7.6 inches d.b.h. were felled and their branches lopped and piled for burning in stand openings. This accounted for about 25 piles of slash per acre which were burned in the fall of 1936. The ribes averaging about 15 bushes per acre were removed at the time area No. 8 was worked.

Clear-cut area No. 11 - A mature 161-200 year old stand which was clear cut of white pine in 1914-1916 when in private ownership. The unmerchantable residual stand was felled and broadcast burned in 1936. Eradication measures had been applied previous to the 1936 treatment and had resulted in the removal of approximately 100 ribes per acre.

Clear-cut area No. 14 - A mature 121-161 year old stand of white pine which was clear cut and the residual hemlock and white fir felled in 1936. The area was broadcast burned in 1937. During control work prior to the 1936 stand treatment approximately 125 ribes per acre had been removed.

Kaniksu National Forest.

Hannah Predisposal area - A mature 161 plus year old stand was composed of white pine, larch, white fir, hemlock and Douglas fir. The defective and a large percentage of the unmerchantable species were removed by felling to create shelterwood conditions favorable for the establishment of the more valuable species. The slash was piled and progressively burned during the fall and winter seasons of 1935 and 1936. Eradication measures were applied previous to the disposal work on this area and approximately six R. lacustre were removed per acre.

Bear Paw Partial Cut area - An early maturing 80 year old stand was dominated by fast growing white pine which made up 99 percent of the original volume of 29,406 board feet per acre. The remainder of the stand was composed of larch, Douglas fir, lodgepole pine and cedar. A partial cut was made of the white pine removing 28 percent of the total volume or 29 percent of the volume of white pine in 1937. The slash was piled and progressively burned in small piles. About 21 R. lacustre per acre were removed from this area before the logging.

W 2482, 2483. Deception Creek Experiment Station, Shelterwood Area No. 12. Alternate strips of clear cutting, slash broadcast burned, combined with shelterwood cutting, slash piled and burned, north exposure. Undesirable trees felled to create residual shelterwood of white pine seed trees. Medium broadcast burn responsible for two and one-fourth more ribes. Note general heavy vegetative cover on broadcast area contrasted to spotty cover in shelterwood.

W 2485. Deception Creek Experiment Station, Area No. 6. Pre-logging disposal of undesirable trees by felling, slash piled and burned, south exposure. Note scarcity of vegetative cover. Conditions slightly favorable for ribes in spots.

W 2484 Deception Creek Experiment Station, Area No. 8. Same type of treatment as described under W 2485 to create shelterwood conditions favorable for establishment of white pine reproduction in advance of logging. Note general vegetative cover and conditions favoring the germination and survival of ribes seedlings on north exposure.

DISCUSSION

Stand improvement in mature stands, which is primarily concerned with the disposal of undesirable trees, can be classified into the following four methods: (1) Partial disposal of inferior and defective species after logging to insure an adequate stocking of desirable reproduction. (2) Partial disposal in advance of logging to create favorable conditions for the establishment of desirable reproduction by removing the inferior species. When this reproduction is satisfactorily established the residual overwood composed almost entirely of merchantable trees is clear cut. (3) Complete disposal by broadcast burning. The only practicable method of restoring to productivity areas supporting large volumes of defective, totally unmerchantable and dead trees is to remove all merchantable timber, clear cut the residual stand and broadcast burn. (4) The group shelterwood method of cutting, or a combination of partial and complete disposal where conditions permit its advantageous application in strips.

No one method can ever be relied upon to meet the full silvicultural and ecological requirements for both the adequate restocking of white pine and the satisfactory suppression of ribes. Some of the best possibilities of ribes suppression undoubtedly lie in special adaptations of general forest management procedures such as selective logging. Stand improvement with a minimum of disturbance and the suppression of fires would tend to reduce the upland ribes hazard to a minimum. Also the presence of relatively heavy shade on the ground cast from 25 or more residual trees tends to cause a progressive dying out of the ribes seedlings. Unless the initial disturbance is general enough to bring about complete germination of all stored ribes seed, subsequent disturbances may be followed in each case by additional crops of ribes seedlings. If disposal measures are undertaken before logging there is every possibility that a ribes population will originate succeeding both the predisposal measure and the ultimate logging of these areas. This of course will necessitate adequate protection measures succeeding each disturbance since a number of years must elapse between operations to assure the establishment of white pine reproduction. If partial disposal measures are applied following logging, the operation should be made a part of the actual logging of the area or closely follow it. Such a procedure would in reality cause only one major disturbance and the regeneration of ribes would soon be relatively complete. Complete disposal, if applied shortly after logging, consumes practically all of the forest mantle and permits the maximum germination of undestroyed stored ribes seed in the shortest time. Ribes populations will normally be large on these areas but by the timely removal of the seedlings before the seeding starts again it is highly probable these areas will never be reinvaded by ribes no matter how many or how severe are additional disturbances. Since the longevity of ribes seed is not definitely known, there is every indication that redisturbance of partial disposal areas will cause additional waves of ribes populations. As long as 25 or more residual trees are held on such areas few ribes will become established, thus lowering present protection costs. These costs in the end may become higher than on areas subjected to complete disposal where the ribes hazard is eliminated once and for all time by the removal of seedlings before the production of large quantities of seed commences.

The results showing the effect of mature stand improvement on the growth and regeneration of ribes seedlings are presented in table 5. Except for a

TABLE NO. 5

EFFECT OF MATURE STAND IMPROVEMENT ON THE GROWTH AND REGENERATION OF RIBES LACUSTRE

Plot No. and Location	Slash Disposal	Year Plot Estab-lished	Acreage Checked	Number Seedlings and Amount Live Stem Per Acre Each Year After Treatment								Accumulative Number Seedlings and Amount Live Stem Per Acre Each Year After Treatment								F.L.S. Per Seedling	No. Leaves Per Seedling	No. Infected Seedlings Per Acre	No. Infected Leaves Per Acre	Expo-sure	Soil Moisture Content	Amount Associated Vegetative Cover (Percent)	Light Intensity (Percent Full Sunlight)
				1935		1936		1937		1938		1935		1936		1937		1938									
				No.	F.L.S.	No.	F.L.S.	No.	F.L.S.	No.	F.L.S.	No.	F.L.S.	No.	F.L.S.	No.	F.L.S.	No.	F.L.S.								
Shelterwood and Clear-cutting in Alternate Strips																											
Area No. 12 D.C.E.S.[a]	Shelterwood, slash piled and burned, 1936	1935	1.5	1	1.2	3	2.7	161	57.3	89	16.1	1	1.2	4	5.2	165	68.1	254	175.4	.69	25	12	57	N	Moderate	26	60
Area No. 12 D.C.E.S.	Clear-cut, slash broadcast burned, 1936	1935	2.0	2	.6	30	23.7	192	267.9	398	177.4	2	.6	32	25.3	224	325.1	622	938.0	1.51	37	137	915	N	Moderate	31	95
Pre-logging Disposal Measures																											
Area No. 6 D.C.E.S.	Felling, slash piled and burned, 1936	1936	1.4			3	.5	68	14.5	111	8.6			3	.5	71	16.0	182	57.1	.34	11	3	5	S	Low	19	40
Area No. 8 D.C.E.S.	Felling, slash piled and burned, 1936	1935	1.5	8	26.6	72	81.1	258	65.8	833	107.4	8	26.6	80	1,116.3	338	333.4	1,171	691.2	.59	15	67	244	N	Moderate	26	35
Area No. 9 D.C.E.S.	Girdling and felling, slash piled and burned, 1936	1935	1.2			1	.1	28	7.8	82	8.9			1	.1	29	8.0	111	28.9	.26	10	6	44	N	Moderate	14	25
Hannah Area Kaniksu N.F.	Felling, slash piled and burned, 1935-1936	1935	2.0			1	.2	3	.3					1	.2	4	.8	4	1.9	.48	42			N	Low	25	55
Complete Disposal - Clear-cut																											
Area No. 11 D.C.E.S.	Slash broadcast burned, 1936	1936	1.3			1	.4	2	2.0	2	1.2			1	.4	3	2.9	5	7.2	1.44	26			S	Low	17	95
Area No. 14 D.C.E.S.	Slash broadcast burned, 1937	1936	1.7																					W	Low	3	95
Partial Cut - White Pine																											
Bear Paw Area Kaniksu N.F.	Slash piled and burned, 1937	1937	3.0							3	.3							3	.3	.1	9			N	Moderate	32	25

[a]D.C.E.S.- Deception Creek Experimental Station, Coeur d'Alene National Forest

single R. viscosissimum seedling found on area No. 12. R. lacustre is the only species of ribes considered in this report. Area No. 12 is a striking example of complete and partial disposal in adjacent strips. Topographically, the shelterwood strips extended as fingers down the slope to within three or four chains of Ames Creek. The clear-cut area embodied this stream zone type with the fingered strips extending toward the ridge top. Approximately 2½ times as many R. lacustre seedlings were found on the clear-cut or complete disposal area as on the shelterwood strips. The degree of burn obtained by complete disposal was classed as medium since practically all duff and a large percentage of the organic mantle had been destroyed. The peak of germination occurred one year after burning on both the shelterwood strips and the complete disposal area except for a three to five chain minor stream zone in the center of the latter area. The continuation of ribes seed germination in this lower zone is probably caused by the cool and moist conditions of the soil which delayed the period favoring the appearance of seedlings. Since this zone has not been segregated from the more characteristic upland conditions on the remainder of the clear-cut area, the peak of ribes seed germination has not been reached on the complete disposal area.

Changed environmental conditions strongly favored live stem growth, development of leaves and the amount of infected bushes on the clear-cut area. Approximately 22 percent of the ribes bushes were found to be infected in this area as compared with five percent on the shelterwood strips. A distinct difference was also noted in the subordinate plant species making up the associated vegetation. The shelterwood maintained rather largely its original plant species whereas on the complete disposal areas these were replaced chiefly by the more sun tolerant herbaceous plants.

These two types of cutting will not affect or vary the time in which effective eradication measures can be applied. After the successful establishment of reproduction the residual white pine seed trees are to be removed from the shelterwood. The extent to which this operation will cause an additional wave of ribes to appear will largely depend upon the disturbance necessary to remove the logs and the subsequent treatment of slash. The survival of ribes seedlings appearing after this second operation will be materially minimized if a relatively heavy stocking of reproduction can be established on the shelterwood strips previous to the removal of the white pine seed trees. To discourage the germination of ribes seed when the residual stand is removed in the shelterwood, skidding of logs wherever possible should be limited to the adjacent complete disposal area. This recommendation is based on the assumption that practically complete germination of ribes seed has taken place on the clear-cut areas.

Four areas were available on which partial disposal of undesirable trees in advance of logging could be studied to determine the effect on the growth and regeneration of ribes seedlings. Areas Nos. 6 and 8 had relatively the same type of treatment applied but on different slopes. Area No. 8, occupying a north exposure was found to have approximately six and one half times as many ribes seedlings as were found on area No. 6, a south slope. The north slope strongly favored the growth and development of the seedlings. This slope also showed the largest percentage of infected ribes and the greatest intensification of the rust. On area No. 9 the larger trees were girdled instead of being felled. Trees under 7.6 inches d.b.h. were felled and the slash piled at the rate of about 25

piles per acre. Ribes invariably occurred around these burned slash piles at the approximate rate of four seedlings per pile. Heavy shade strongly inhibited the development of ribes on this area and only a small percentage of the seedlings were well established. The Hannah area, probably for lack of viable duff stored seed, has never been a ribes problem. In such areas disturbance will have no bearing on eradication work.

Two operations are necessary to complete pre-logging disposal measures in advance of logging in mature stands. The first is the removal of undesirable species or the source of unwanted seed in advance of logging, and the second is the actual logging of the residual stand. In connection with the first, girdling has proved highly satisfactory toward the discouragement of ribes seed germination, having caused only about one tenth the number of seedlings that were caused by the complete felling of unmerchantable trees. Concerning the second operation, the removal of the merchantable residual stand, there appears to be little opportunity to discourage the germination of ribes seed resulting from the mechanical disturbance necessary to remove the logs; ribes numbers, however, may be materially reduced if the slash is not burned. If reproduction can be satisfactorily established before or shortly after the logging of these areas, ribes seedlings that do appear should rapidly and progressively die out because of severe competition from the young developing forest.

Two areas are being studied on which the complete disposal measures had been applied under experimental management. A heavy burn was obtained on both areas although it was evident that area No. 11 had not been as severely burned as area No. 14. In either case practically all the organic mantle had been consumed. A total of only five ribes seedlings per acre was found on area No. 11. It seems apparent that the mortality of ribes seedlings is affected not only by heavy shade but by the dryness of exposed sites such as would be produced by complete disposal measures on south slopes. The results of ecology studies have also shown that complete disposal measures properly executed will destroy a large portion of the stored ribes seed on the more moist exposures. If ribes seedlings do appear and are removed before the seeding problem begins anew on the complete disposal areas it is very unlikely such ground will ever become reinhabited by ribes.

The Bear Paw area, while not exactly catalogued as a stand improvement job approaches logging perfection by materially assisting in ribes suppression. The original stand volume of this area was 29,406 board feet per acre. Although a white pine partial cut removed 28 percent of this volume, the remaining stand is well stocked and casts a heavy ground shade. It is very unlikely that existing conditions beneath this canopy will ever encourage the development of ribes since only three R. lacustre seedlings were found the first year following logging. With a number of cutting cycles possible in this fast growing stand of white pine, ribes regeneration should not become serious until the final and complete removal cut and even then established reproduction may strongly inhibit seedling development.

SUMMARY

Data from the 1938 studies and pertinent information obtained from past ecology work have been assembled to coordinate data on stand improvement and ribes suppression measures. Since it is planned to conduct future ribes ecology studies concurrently with stand improvement experiments, the results of the present studies should be considered as a preliminary report.

There are two fundamental objectives which must be kept clearly in mind if the ecesis of ribes is to be regulated through stand improvement measures. The first objective is to control or minimize the germination of ribes seed which is stored in the undisturbed forest floor. This may be accomplished by avoiding excessive mechanical disturbances and not employing slash disposal measures. The second objective is to create conditions within the stand whereby a minimum number of seedlings will become permanently established. This condition can be obtained by maintaining as near a full forest canopy as possible on the area.

Cleanings or weedings in very young stands cause no major ground disturbance and create stand conditions largely inhibitory to the establishment of ribes seedlings. The piling and burning of slash on weeded areas was found to be the only measure responsible for the appearance of large numbers of ribes. The peak of germination for R. lacustre seedlings following the burning of slash on these areas occurs during the second year. Veteran ribes bushes should be removed before or shortly after the cleaning operation because of their increase in growth development resulting from increased light. The largest percentage of infected ribes bushes was found in the treated stands. Stand weeding greatly facilitates the detection of ribes by the eradication crews. Effective eradication measures can be applied at least in the third year following the cleaning operation. Cleanings or weedings can materially assist in the suppression of ribes if the release type of treatment requires no subsequent disposal of slash.

Thinnings or improvement cuttings in the sapling and pole stands causes a sufficient ground disturbance to result in the appearance of some ribes seedlings. The disturbance and the number of ribes seedlings appearing were observed to be largely in proportion to the degree or severity of thinning. Slash piling and burning were found to be largely the factors responsible for the germination of ribes seed. Moist exposures permitted maximum germination of ribes seedlings in thinned stands. Low thinnings, in general, create conditions favorable for the establishment of ribes by removing trees in the lower crown classes. The residual stand from light low thinnings should rapidly shade out these seedlings. By eliminating undergrowth the below type of thinning facilitates the location of ribes for eradication. Crown thinnings rarely create conditions favoring the development of ribes seedlings unless subsequent wind throw and snow breakage occur. Trees in the lower crown classes are left by this type of thinning, thus maintaining to a large degree the original heavy shade factors. Veteran ribes bushes were found to increase in growth after both types of thinning, although conditions appeared to be less favorable for their development in the crown thinning stands. Either type of thinning will require ribes eradication measures within a ten year period since it appears that natural suppression would not be complete before this time. Of the two types, crown thinning with a minimum amount of cutting and little or no slash burning will come nearest to creating conditions unfavorable for the development of ribes seedlings.

Clear-cut medium burned areas permitted the germination of about 2½ times as many R. lacustre seedlings as adjacent shelterwood strips. Conditions were found to be largely unfavorable for the development of ribes in light shelterwood or selective cuttings. Pre-logging disposal where felling measures were employed resulted in approximately 10½ times as many ribes seedlings as where the larger trees were girdled. Girdling was found to largely maintain original forest cover conditions which strongly inhibited the development of ribes seedlings. Any type of pre logging disposal will require eradication measures before the removal of the merchantable residual stand in order to give protection to the developing white pine reproduction. There are some areas, however, which contain but few stored ribes seed and on which pre-logging measures would not materially affect the control program. In mature stands ribes suppression can be materially aided by stand improvement practices if as near a full forest canopy as possible is maintained on the area. Before the residual trees are cut a full stocking of reproduction should already be established or shortly thereafter the removal cut in order to maintain a full canopy shade.

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